CLAIMS

The invention claimed is:

1. A antenna system comprising:

an array of antenna elements defining a boresight direction;

a variable power divider using a single adjustable control element to divide an input voltage signal into a pair of complimentary amplitude voltage drive signals over a range of voltage amplitude division;

a beam forming network receiving the voltage drive signals and producing a plurality of beam driving signals;

a power distribution network delivering each beam driving signal to one or more associated antenna elements; and

the beam driving signals driving the antenna elements to emit a beam exhibiting a directional tilt with respect to the boresight direction that varies within a range of tilt in response to changes of the voltage amplitude division within the range of voltage amplitude division; and

a field adjustable tilt direction actuator for adjusting the voltage amplitude division and thereby adjusting the directional tilt of the beam.

2. The antenna system of claim 1, further comprising a remote controller for controlling the field adjustable tilt direction actuator.

3. The antenna system of claim 1, wherein the power distribution network implements coordinated phase shifting of the beam driving signals delivered to the antenna elements to cause a desired tilt bias of the range of tilt.

4. The antenna system of claim 3, further comprising a field adjustable tilt bias actuator for adjusting the tilt bias.

5. The antenna system of claim 4, further comprising a remote controller for controlling the field adjustable tilt bias actuator.

6. The antenna system of claim 1, wherein:

the antenna elements are organized into one or more inner sub-arrays located between outer sub-arrays; and

each beam driving signal drives an associated antenna sub-array.

7. The antenna system of claim 6, wherein the number of antenna elements in the outer sub-arrays is greater than the number of antenna elements in the inner sub-arrays for the purpose of reducing sidelobe emission.

8. The antenna system of claim 7, wherein:
the number of outer sub-arrays is two;
the number of inner sub-arrays is two;
the number of antenna elements in each outer sub-array is four; and
the number of antenna elements in each inner sub-array is two.

9. The antenna system of claim 7, wherein:
the number of outer sub-arrays is two;
the number of inner sub-arrays is two;
the number of antenna elements in each outer sub-array is five; and
the number of antenna elements in each inner sub-array is three.

10. The antenna system of claim 6, wherein the power distribution network implements coordinated phase shifting of the beam driving signals delivered to the elements of one or more sub-arrays to cause a desired blurring of the phase matching of the signals emitted by antenna elements of the outer sub-arrays for the purpose of reducing sidelobe emission.

11. The antenna system of claim 10, wherein:
the number of outer sub-arrays is two;
the number of inner sub-arrays is two;
the number of antenna elements in each outer sub-array is four; and
the number of antenna elements in each inner sub-array is four.

12. The antenna system of claim 10, wherein:
the number of outer sub-arrays is two;
the number of inner sub-arrays is two;
the number of antenna elements in each outer sub-array is three; and
the number of antenna elements in each inner sub-array is three.

13. The antenna system of claim 6, comprising two outer sub-arrays and two inner sub-arrays, wherein the beam forming network is a two-by-four orthogonal beam forming network and each beam driving signal comprising a beam component associated with each voltage drive signal.

14. The antenna system of claim 6, comprising two outer sub-arrays and two inner sub-arrays, wherein the beam forming network is a four-by-four Butler matrix and each beam driving signal comprising a beam component associated with each voltage drive signal.

15. The antenna system of claim 1, wherein each antenna element is a dual-polarization antenna element, further comprising a similar a variable power divider, beam forming network, and power distribution network for each polarization.

16. The antenna system of claim 15, wherein the field adjustable tilt direction actuators are mechanically linked to each other to adjust the beam tilt for both polarities in a coordinated manner.

17. The antenna system of claim 6, wherein:

each antenna element is a dual-polarization antenna element, further comprising a similar a variable power divider, beam forming network, and power distribution network for each polarization; and

wherein the power distribution network implements coordinated phase shifting of the beam driving signals delivered to the sub-arrays to cause a desired tilt bias of the range of tilt for each polarization.

18. The antenna system of claim 17, further comprising a field adjustable tilt bias actuator for adjusting the tilt bias for both polarities in a coordinated manner.

19. The antenna system of claim 1, further comprising:

a substantially flat main panel defining a longitudinal axis substantially perpendicular to the boresight direction;

the main panel supports the variable power divider, the power distribution network, and the array of antenna elements in a spacing configuration having a substantially vertical distribution;

the array divided into one or more inner sub-arrays located vertically between outer sub-arrays; and

wherein the beam forming network is configured as a double-sided, edge-connected module mounted to the main panel.

20. A antenna system comprising:

a an array of antenna elements defining a boresight direction;

a variable power divider receiving and dividing an input voltage signal into a pair of matched phase, complimentary amplitude voltage drive signals exhibiting constant phase delay through the variable power divider over a range of voltage amplitude division;

a beam forming network receiving the voltage drive signals and producing a plurality of beam driving signals;

a power distribution network delivering each beam driving signal to an associated sub-array; and

the beam driving signals driving the antenna elements to emit a beam exhibiting a directional tilt with respect to the boresight direction that varies within a range of tilt in response to changes of the voltage amplitude division within the range of voltage amplitude division.

21. The antenna system of claim 20, further comprising:

a substantially flat main panel defining a longitudinal axis substantially perpendicular to the boresight direction;

the main panel supports the variable power divider, the power distribution network, and the array of antenna elements in a spacing configuration having a substantially vertical distribution;

the array divided into one or more inner sub-arrays located vertically between outer sub-arrays; and

wherein the beam forming network is configured as a double-sided, edge-connected module mounted to the main panel.

22. The antenna system of claim 21, wherein the power distribution network implements coordinated phase shifting of the beam driving signals delivered to the sub-arrays to cause a desired tilt bias of the range of tilt.

23. The antenna system of claim 21, further comprising a field adjustable tilt bias actuator for adjusting the tilt bias.

24. The antenna system of claim 21, wherein the number of antenna elements in the outer sub-arrays is greater than the number of antenna elements in the inner sub-arrays for the purpose of reducing sidelobe emission.

25. The antenna system of claim 21, wherein the power distribution network implements coordinated phase shifting of the beam driving signals delivered to the elements of one or more sub-arrays to cause a desired blurring of the phase matching of the signals emitted by antenna elements of the outer sub-arrays for the purpose of reducing sidelobe emission.

26. A antenna system comprising:

a an array of antenna elements defining a boresight direction and one or more inner sub-arrays located between outer sub-arrays;

a variable power divider producing complimentary amplitude voltage drive signals over a range of voltage amplitude division;

a beam forming network receiving the voltage drive signals and producing a plurality of beam driving signals;

a power distribution network delivering each beam driving signal to one or more associated antenna elements;

the beam driving signals driving the antenna elements to emit a beam exhibiting a directional tilt with respect to the boresight direction that varies within a range of tilt in response to changes of the voltage amplitude division within the range of voltage amplitude division; and

wherein the power distribution network implements coordinated phase shifting of the beam driving signals delivered to the sub-arrays to cause a desired tilt bias of the range of tilt.

27. The antenna system of claims 26, further comprising:

a substantially flat main panel defining a longitudinal axis substantially perpendicular to the boresight direction;

the main panel supports the variable power divider, the power distribution network, and the array of antenna elements in a spacing configuration having a substantially vertical distribution;

the array divided into one or more inner sub-arrays located vertically between outer sub-arrays; and

wherein the beam forming network is configured as a double-sided, edge-connected module mounted to the main panel.

28. A antenna system comprising:

a an array of antenna elements defining a boresight direction and one or more inner sub-arrays located between outer sub-arrays;

a variable power divider producing complimentary amplitude voltage drive signals over a range of voltage amplitude division;

a beam forming network receiving the voltage drive signals and producing a plurality of beam driving signals;

a power distribution network delivering each beam driving signal to one or more associated antenna elements;

the beam driving signals driving the antenna elements to emit a beam exhibiting a directional tilt with respect to the boresight direction that varies within a range of tilt in response to changes of the voltage amplitude division within the range of voltage amplitude division;

wherein the number of antenna elements in the outer sub-arrays is greater than the number of antenna elements in the inner sub-arrays for the purpose of reducing sidelobe emission

29. The antenna system of claims 26, further comprising:

a substantially flat main panel defining a longitudinal axis substantially perpendicular to the boresight direction;

the main panel supports the variable power divider, the power distribution network, and the array of antenna elements in a spacing configuration having a substantially vertical distribution;

the array divided into one or more inner sub-arrays located vertically between outer sub-arrays; and

wherein the beam forming network is configured as a double-sided, edge-connected module mounted to the main panel.

30. A antenna system comprising:

a an array of antenna elements defining a boresight direction and one or more inner sub-arrays located between outer sub-arrays;

a variable power divider producing complimentary amplitude voltage drive signals over a range of voltage amplitude division;

a beam forming network receiving the voltage drive signals and producing a plurality of beam driving signals;

a power distribution network delivering each beam driving signal to one or more associated antenna elements; and

the beam driving signals driving the antenna elements to emit a beam exhibiting a directional tilt with respect to the boresight direction that varies within a range of tilt in response to changes of the voltage amplitude division within the range of voltage amplitude division; and

a field adjustable tilt direction actuator for the adjusting voltage amplitude division and thereby adjusting the directional tilt of the beam; and

wherein the power distribution network implements coordinated phase shifting of the beam driving signals delivered to the elements of one or more sub-arrays to cause a desired blurring of the phase matching of the signals emitted by antenna elements of the outer sub-arrays for the purpose of reducing sidelobe emission.

31. The antenna system of claims 26, further comprising:

a substantially flat main panel defining a longitudinal axis substantially perpendicular to the boresight direction;

the main panel supports the variable power divider, the power distribution network, and the array of antenna elements in a spacing configuration having a substantially vertical distribution;

the array divided into one or more inner sub-arrays located vertically between outer sub-arrays; and

wherein the beam forming network is configured as a double-sided, edge-connected module mounted to the main panel.